GSA news & information

SUPPLEMENT TO GEOLOGY MAGAZINE

DECEMBER 1977

Penrose Conference planned for September 24–28 at Cambridge, England

A Penrose Conference, Magnetic Structure of Oceanic Basement, sponsored by the Geological Society of America, will be held at Churchill College, the University of Cambridge, England, from September 24 to September 28, 1978.

There is a wealth of new data and ideas regarding the magnetization of the oceanic crust arising from deep-towed and surface-towed magnetometer studies and from detailed investigation of samples obtained from drilling, submersibles, dredging, and ophiolites. The major aim of this conference will be to assemble a broad spectrum of geoscientists to discuss these recent results and models. In addition to paleomagnetists, rock magnetists, and marine geophysicists, active participation is being sought from workers in the fields of oceanic basement lithology, structure, generation, and evolution. Sessions are being planned on (1) DSDP drilling results, (2) ocean crust formation, (3) magnetic anomaly inversion models, (4) ophiolites, and (5) crustal structure and evolution. The format of the meeting will *not* be similar to GSA or AGU meetings with their large numbers of contributed papers. Emphasis will be placed on informal working discussions, roundtable sessions, and active participation of all conferees.

The conference is scheduled to last five days, with an optional field trip being planned into the fens of Cambridgeshire and Norfolk, one of the most beautiful countrysides in all England. The registration fee will be approximately $195 and will include lodging, all meals, and the cost of the field trip. Transportation is not included but charter flight arrangements from North America are being investigated. If interested in attending, do not wait for an invitation. Contact one of the convenors listed below as soon as possible to allow sufficient time for planning and logistics.

James M. Hall, *Department of Geology, Dalhousie University, Halifax, Nova Scotia, Canada.*

H. P. Johnson, *Department of Oceanography, University of Washington, Seattle, Washington 98195.*

Research proposals solicited by U.S.G.S.

The United States Geological Survey requests proposals for research contracts/grants under the continuing Earthquake Hazards Reduction Program. The general areas of interest are

A. Earthquake Hazards Studies. Programs sought include evaluation of earthquake potential, assessment of hazards, prediction of ground motion, estimation of earthquake losses, preparation of geologic and land-use maps, and investigation of reservoir-induced seismicity.

B. Earthquake Prediction Studies. Programs sought include studies of possible earthquake precursors; development of techniques to predict the time, location, and magnitude of earthquakes; field programs to monitor manifestations of stress and strain changes; and development of computer-based models of physical processes related to earthquakes.

C. Studies in Support of Both A and B. Programs sought include investigations of the physical basis of earthquakes, studies of crust and upper mantle behavior, laboratory investigations of rock properties, and studies of regional seismicity.

Written inquiries concerning this program, and requests for Proposal Information Package No. RFP-460W, should be addressed to

Contracting Officer, U.S. Geological Survey, Building 1, Room 201, 345 Middlefield Road, Menlo Park, California 94025.

Due date for receipt of proposals is February 10, 1978. It is anticipated that funding of selected programs will start on or about October 1, 1978.

Organizing Committee announces 26th International Geological Congress

The Organizing Committee of the 26th International Geological Congress would like you to note the fact that this congress will take place in Paris, France, from July 7 to 17, 1980, and that you are cordially invited to attend.

The "A" excursions will be held before the congress from June 27 to July 5, while the "C" excursions will be held afterward from July 19 to 27. These excursions will cover practically all of Europe, except for the countries which participated in the 23rd Congress or are candidates for the organization of the 27th Congress. The scientific program is as follows:

1. There will be twenty sections: Petrography; Mineralogy; Paleontology; Stratigraphy; Tectonics; Marine geology, sedimentology, and sedimentary petrography; Precambrian; Quaternary geomorphology; Geophysics; Geochemistry; Remote sensing; Mathematical geology and geological information; Metallogeny and mineral ores; Fossil energy sources; Hydrogeology; Materials and engineering geology; Geologic hazards; Planetary Science; History of geology; Education and training. Symposia will be organized for the various sections in association with organizations affiliated with the International Union of Geological Sciences. Abstracts of papers should be received by December 1, 1979. The theme subjects of sections and symposia are given in the first circular.

2. Seven colloquia will be held: Mineral resources, Energy resources, Geology of continental margins, Geology of the oceans, Geology of Alpine chains descended from the Tethys, Geology of Europe from the Precambrian to the post-Hercynian sedimentary basins, Geology of France. The organizers of these colloquia will call for communications.

During the congress, the following will also be held: (a) A scientific and technical exhibition, (b) Showing of scientific films, (c) "B" excursions for periods of one or two days, (d) A social program and a program for guests of the members.

The first circular will be sent out in October 1977 and responses should reach the Secretary of the Congress by April 1, 1978.

Those interested in attending the congress who have not received the circular by December 15, 1977, should request one from

Secretariat Général du 26ème Congrès
géologique international
Maison de la Géologie
77-79, rue Claude Bernard
75005 Paris, FRANCE.

USGS Open-File Reports now available

Effective October 1, 1977, the U.S. Geological Survey announced that open-file reports are now available by direct-mail sales. Purpose of the program is to furnish microfiche or paper-duplicate copies of open-file reports from a single, centrally-located facility; to provide faster order-filling service to the public for copies of open-file reports; and to increase the availability of earth-science information to the scientific community.

Order USGS open-file reports from Open-File Services Section, Branch of Distribution, U.S. Geological Survey, Box 25425, Federal Center, Denver, CO 80225. (Telephone: 303-234-5888).

Price information will be published in the monthly listing "New Publications of the Geological Survey."

This facility will stock open-file reports only. Please do not mix orders for open-file reports with orders for any other USGS products. Checks or money orders, in exact amount for open-file reports ordered, should be made payable to U.S. Geological Survey. Prepayment is required.

Order by series and number (such as Open-File Report 77-123) and complete title.

Inquiries concerning this new program should be sent to the address given above.

Memorial preprints ready for free distribution

The following memorial preprints are now available for distribution, free of charge:

Agatin Townsend Abbott, 1917–1975, by G. A. Macdonald; Paul Harrison Bird, 1900–1974, by F. Irving; John Manning Birdsall, 1902–1975, by P. E. LaMoreaux and H. C. Barksdale; Bernard William Blanpied, 1897–1975, by C. N. Valerius; Arthur Edward Brainerd, 1885–1974, by G. R. Downs; Carl Colton Branson, 1906–1975, by L. R. Wilson; Maurice Lyman Brashears, 1908–1975, by J. B. Graham; Francis Cameron, 1902–1975, by F. S. Miller; Frank Cook Greene, 1886–1975, by W. B. Howe; David Tressel Griggs, 1911–1974, by J. M. Christie; Horacio J. Harrington, 1910–1973, by J. J. De Bendetti; Olaf Holtedahl, 1885–1975, by C. Oftedahl; Walter Frederick Hunt, 1882–1975, by K. K. Landes; Marshall Kay, 1904–1975, by R. H. Dott, Jr.; Samuel Howell Knight, 1892–1975, by J. D. Love and J. M. Love; Davis M. Lapham, 1931–1974, by A. A. Socolow; Chester Ray Longwell, 1887–1975, by A. D. Howard and W. C. Smith.

Thomas Ellison Mullens, 1925–1975, by L. C. Craig; Charles Merrick Nevin, 1892–1975, by L. de A. Gimbrede; Clarence Samuel Ross, 1880–1975, by T. P. Thayer; Francis Ruellan, 1894–1974, by Professor J. Dresch; Rolf F. Rutsch, 1902–1975, by H. D. Hedberg; Frank Caleb Sturges, 1909–1975, by S. S. Philbrick; Hans Ernst Thalmann, 1899–1975, by W. W. Hay; George Dewey Thomas, 1898–1975, by C. N. Valerius; Francis M. Van Tuyl, 1887–1975, by L. W. LeRoy; Everett Pepperrell Wheeler 2nd, 1900–1974, by S. A. Morse; Max Greeg White, 1916–1975, by J. A. Reinemund; Oscar Wilhelm, 1897–1975, by J. D. Edwards; Horace Elmer Wood, 2nd, 1901–1975, by G. G. Simpson; Charles Douglas Woodhouse, 1888–1975, by R. W. Webb and R. M. Norris.

Attention: Computerized Registry for Women in Science and Engineering expanded

The Association for Women in Science (AWIS) announces the expansion of its computerized Registry of Women in Science and Engineering. The Registry contains brief biographies of women in all fields of science and engineering and provides job candidates for recruiters from business, government, and academia. The Registry also serves as a resource list for advisory panels and other projects involving women in science.

For more information write AWIS Registry, Suite 1122, 1346 Connecticut Avenue NW, Washington, D.C. 20036.

Geological Society of America
Cordilleran Section

Guidebooks for 1977 meeting, Sacramento, California

1.	Guidebook: Paleozoic-Mesozoic Rocks of the Northern Sierra Nevada	$ 2.50	________
2.	Field Trip Guide to the Geysers-Clear Lake Area	$ 4.00	________
3.	Geological Road Log for the California Mother Lode Country along Highway 49 between Mariposa and Grass Valley	$ 1.00	________
4.	Guidebook: Tectonics and Stratigraphy of the Calaveras Complex, Central Sierra Nevada Foothills	$ 1.50	________
5.	Guidebook: San Andreas Fault in Marin County with Section across the Coast Ranges from Sacramento to San Francisco	$ 4.00	________
6.	Guidebook to the Geology of the Klamath Mountains, Northern California	$ 7.50	________
7.	Field Trip Guide to the Kings-Kaweah Suture, Southwestern Sierra Nevada Foothills, California	$ 2.00	________
8.	Field Guide: Great Valley Sequence, Sacramento Valley	$ 4.50	________
9.	Guidebook: Plate Tectonic History of the Yolla Bolly Junction, Northern California	$ 1.50	________
10.	Field Trip around the Sacramento-San Joaquin Delta	$ 1.50	________
	Entire set, guides 1-10 above (no discount)	$30.00	________

This form serves as a receipt when validated.
All orders must be prepaid. Make checks payable to Cordilleran Section,* Geological Society of America.
No discounts available.
Price includes shipping, handling, and tax.

Address all correspondence to D. McGeary
Geology Department
California State University, Sacramento
Sacramento, CA 95819

*Please note correction.

gsa publications

Stratigraphic, Paleontologic, and Paleoenvironmental Analysis of the Upper Cretaceous Rocks of Cimarron County, Northwestern Oklahoma

MEMOIR 149 — By Erle G. Kauffman, Donald E. Hattin, and J. Dan Powell. 1977. x + 150 pages, 12 figures, 11 tables, plate section, description of measured sections on one 98-frame microfiche for use on 24× readers. ISBN: 0-8137-1149-5. $19.00.

The central part of the Western Interior Cretaceous marine basin—an area that includes southeastern Wyoming, central and eastern Colorado, western Kansas, northeastern New Mexico, and northwestern Oklahoma—contains one of the most complete and extensively studied records of large-scale cyclic sedimentation in the world. From numerous well-exposed sections in Colorado and Kansas, a detailed evolutionary history of epeiric marine environments and faunas has been constructed and analyzed. The present study indicates that this highly refined biostratigraphic system can be extended readily into the Cretaceous sequence exposed in Cimarron County, Oklahoma, an area centrally situated between the well-known Cretaceous areas of Colorado, Kansas, and Texas. The authors concluded that paleontologic and stratigraphic study of Cretaceous outcrops in northwestern Oklahoma would not only be a major contribution to their knowledge of poorly studied Cretaceous rocks of the Western Interior but also would furnish important keys to the physical and biostratigraphic relationships of the Colorado and Kansas sections to those in northern Texas.

Part 1 (Kauffman, Hattin, and Powell) includes description of the section, lithostratigraphy, zonation and correlation by macrofaunal and microfaunal criteria, regional correlation and facies analysis, and paleoenvironmental interpretations based on physical and biological data. Kauffman and Powell present the systematic paleontology upon which these interpretations are based, in Part 2.

The section studied, of Cenomanian–Early Turonian age, includes upper sandy beds of the Dakota Group; lower shale member, Thatcher Limestone Member, and upper shale member of the Graneros Shale; and the carbonate-rich Lincoln Member, Hartland Member, and Bridge Creek Limestone Member of the Greenhorn Formation. Dakota, Graneros, and Greenhorn strata represent most of the transgressive part of the Greenhorn depositional cycle. Stratigraphically and lithologically, the Graneros and Greenhorn of Cimarron County, Oklahoma, compare most closely with sections exposing the same units in westernmost Kansas; several bentonite and limestone beds are demonstrably common to the two areas. The Cimarron County section also compares closely with the Cenomanian–Lower Turonian section on the Model anticline of southeastern Colorado. Comparison of the Oklahoma section with that of northern Texas confirms the general similarity of the two stratigraphic sequences but with marked diachrony of lithic equivalents in the lower part of the section due to the southeastward transgression during Cenomanian time.

Faunas of the Cimarron County section are a mixture of Western Interior and Gulf Coast taxa and include several cosmopolitan or intercontinentally distributed species. Biostratigraphic correlation and application of European stage terminology is readily accomplished in the Greenhorn Formation of Cimarron County. Study of fossil associations served to distinguish seven of the ecological assemblages that have been recognized elsewhere in the Western Interior by Kauffman.

In Part 2, macroinvertebrates and foraminifera of the Cimarron County section are documented, and most species are described in detail. Included are descriptions or discussion of 16 species of foraminifera, 10 species or species groups of ammonites, 5 species of gastropods, 9 species of noninoceramid bivalves, 13 species of inoceramid bivalves, and 1 species each of brachiopods, corals, and annelids. Several new species and subspecies are described.

Stratigraphy and Paleobotany of the Golden Vally Formation (Early Tertiary) of Western North Dakota

MEMOIR 150 — By Leo J. Hickey. 1977. x + 294 pages, 40 figures (including map, in color, folded in pocket), 17 tables, 55 plates. ISBN: 0-8137-1150-9. $34.00.

Deposition of the Golden Valley Formation, of fluvial origin, spanned the Paleocene-Eocene boundary and represented the final episode of sedimentation in the Williston basin. The study is unusual in that it integrates diverse data from a single formation with the aim of developing a detailed picture of the causes of environmental and biotic changes across a major time boundary. Throughout the work, a sustained effort was made to separate the effects of regional factors, such as tectonic and climatic changes, from features that resulted entirely from local influences.

Six stratigraphic traverses, assembled from more than 70 measured sections, provide a continuous profile throughout the entire formation, which is approximately 55 m thick. The detailed distribution map of the formation, in color at 1:250,000, covers approximately one-fourth of North Dakota at four times the scale of the present state geologic map. This new map will be of considerable importance not only for those seeking areas underlain by the kaolinitic clays of the formation but also for those studying the structural trends of the Williston basin.

Research on the megafossil plants of the formation has led the author to the formulation of a new and more rigorous method—leaf architectural analysis—for systematically determining unknown leaves. An appendix describes and illustrates the terminology. The identifications arrived at in this study, many representing revisions of erroneous determinations reached in the past, constitute the first application of these new techniques. Systematic descriptions are included. The number of plants collected and the close spacing of localities permitted a detailed biostratigraphic study of the transition from a Paleocene to an Eocene flora with a precision usually possible only with pollen. The early Eocene part of the Golden Valley flora is the earliest known megaflora of Eocene age in North America.

The lower member of the Golden Valley Formation consists of kaolinite-rich clay, which is a source of ceramic clay and potentially of alumina. Sediments of this unit become finer grained upward, and this trend is accompanied by a decrease in the number of lowland forest plants and an increase in marsh and aquatic vegetation. The contact between the lower and upper members coincides very closely with the position of the Paleocene-Eocene boundary and is marked by a sharp change in clay-mineral content from kaolinite to illite and montmorillonite. In addition, Eocene indicator plants such as *Salvinia*, *Lygodium*, *Hemitelia*, and *Platycarya* first appear in strata immediately above the contact. Sedimentary deposits of the upper member become increasingly coarse upward, and lowland forest plants return to dominance; these beds contain the highest of the lignitic strata of this region. Paleobotanical evidence indicates a rise in mean annual temperature from approximately 15 °C in late Paleocene time to 18.5 °C in early Eocene time. By far the greatest impetus to vegetational change from the Paleocene to the Eocene, however, may have been a substantial increase in the average temperature of the coldest month from an estimated 6 to 12 °C.

December BULLETIN briefs

Brief summaries of articles in the December 1977 GSA Bulletin *are provided on the following pages to aid members who chose the lower dues option to select* Bulletin *separates of their choice. The document number of each article is repeated on the coupon and mailing label in this section.*

• 71201—Late Wisconsinan ice recession in east-central New York.

Donald B. Krall, Department of Earth and Planetary Sciences, Kean College of New Jersey, Union, New Jersey 07083. (14 p., 9 figs., 3 tbls.)

Previous uncertainty in the continuity of mapped moraines of central New York east of the Utica meridian resulted from the rugged topography and the complex interaction of the Mohawk and Ontario ice lobes. Till composition, fabric, stratigraphy, and drumlin morphology demonstrate that Valley Heads drift was deposited by a major readvance of the Ontario lobe after recession of the Mohawk lobe. This study names and describes a previously unrecognized moraine between Cassville and Cooperstown, New York. The moraine crosses several divides, permitting calculation of ice-front gradients, which are comparable to those of active, steady-state, temperate glaciers. Ice-slope considerations and topography suggest correlation of the Cassville-Cooperstown ice border with the Wagon Wheel Gap Substage in the Catskill Mountains.

Mapping the Cassville-Cooperstown moraine makes possible the tracing of older recessional positions of the ice sheet. Recession is inferred as uniform, with little local-valley control, suggesting an active retreating ice front rather than widespread stagnation. Although previous writers have suggested otherwise, ice recession was subparallel to the Terminal moraine in Pennsylvania and perpendicular to striations and to through valleys.

Regional correlations imply that deposition of the Cassville-Cooperstown moraine was simultaneous with the Rosendale readvance in the Wallkill Valley inferred at 14,800 radiocarbon yr B.P. Recession of the Mohawk lobe and readvance of the Ontario lobe to the Valley Heads moraine is suggested to have been concurrent, resulting from initial isostatic rebound subsequent to deglaciation of the Adirondack dome.

• 71202—Geochemistry of tholeiites of the Basic Igneous Complex of northwestern South America.

P. J. Goossens, W. I. Rose, Jr., Decio Flores, Department of Geology and Geological Engineering, Michigan Technological University, Houghton, Michigan 49931 (present addresses, Goossens: Department of Geology, Rangoon Arts and Sciences University, UNDP, Box 650, Rangoon, Burma; Flores: Departmento de Petroleo, Universidad de Oriente, Venezuela). (10 p., 10 figs., 5 tbls.)

Chemical analyses of basaltic rocks from the Basic Igneous Complex of the Pacific coastal areas of northern South America clearly demonstrate a consistent tholeiitic affinity for this belt and a geochemical similarity of samples from Ecuador, Colombia, and Panama. The rocks are more like ocean-ridge tholeiites than other varieties, but they have higher than expected K, Sr, and Rb contents. Most probably, alteration has caused these anomalies, but a firm conclusion has been frustrated by the lack of correlation of concentration of these elements with the degree of three types of microscopically observable secondary mineralogic changes in the rocks. The rocks form a bimodal geochemical population, about two-thirds basalt and one-third basaltic andesite; both groups are geographically widespread. The increased geochemical information confirms the correlation of this complex with similar rocks in the Cordillera Occidental of Colombia and Ecuador and the Nicoya Peninsula of Costa Rica.

• 71203—Granitic and metamorphic rocks of the Taif area, western Saudi Arabia.

A. O. Nasseef, Department of Geology, King Abdulaziz University, P.O. Box 1540, Jeddah, Saudi Arabia; I. G. Gass, Department of Earth Sciences, The Open University, Milton Keynes MK7 6AA, Great Britain. (10 p., 4 figs., 8 tbls.)

The Taif area occupies 170 km^2 at the western margin of the Saudi Arabian Hijaz plateau, where granitic rocks, which form about 55% of the total outcrop, have been intruded into amphibolites and quartzofeldspathic gneisses. The host rocks have been metamorphosed to the almandine-amphibolite facies and have petrographic and geochemical features that suggest that they were originally igneous rocks of calc-alkalic affinity. The granitic intrusions have been divided into four groups (G_1, G_2, G_3, and G_4) on the basis of field relations, chemistry, and textures; G_1 through G_3 are synkinematic, and G_4 is postkinematic. The granitic rocks are calc-alkalic. Isotopic data suggest that they were emplaced between 595 and 525 m.y. ago; initial $^{87}Sr/^{86}Sr$ ratios (0.703 to 0.710) indicate an origin by partial fusion of the mantle or anatexis of the lower crust. Field, geochemical, and petrographic studies suggest emplacement in an island-arc environment. This is compatible with other investigations that have led to the conclusion that the crystalline basement of Arabia and northeast Africa is the product of cratonization of island arcs over a period of 600 m.y. (from 1,100 to 500 m.y. ago). The Taif granitic rocks represent final phases in the episodic cratonization process.

• 71204—Organic carbon in surface sands seaward of Altamaha and Doboy Sounds, Georgia.

Paul R. Pinet, Robert W. Frey, Department of Geology, University of Georgia, Athens, Georgia 30602. (9 p., 11 figs., 1 tbl.)

Organic-carbon levels typically are low (<0.2%) in shelf sands off Sapelo Island, Georgia. However, a distinct lobate belt of relatively "carbon-rich" sand (>0.3% organic carbon), concave landward, is located at sound entrances around the seaward periphery of ebb-tidal shoal complexes. This distribution pattern indicates that organic detritus, derived mainly from salt marshes, is exported from the sounds and is deposited just offshore because of waning hydraulic tidal currents combined with negligible wave activity. Organic carbon transported from the sounds to the inner shelf evidently helps support a thriving macrobenthic community consisting dominantly of polychaetes, mollusks, and crustaceans.

• 71205—Structural relationships in the Antalya ophiolite complex, Turkey: Possible model for an oceanic ridge.

T. Juteau, Laboratoire de Minéralogie–Pétrographie, Institut de Géologie, 1 Rue Blessig, 67084 Strasbourg Cedex, France; A. Nicolas, Laboratoire de Géologie Structurale–Tectonophysique, B.P. 1044, 44037 Nantes Cedex, France; J. Dubessy, Laboratoire de Minéralogie–Pétrographie, Institut de Géologie, 1 Rue Blessig, 67084 Strasbourg Cedex, France; J. C. Fruchard, Ecole Nationale Supérieure de Géologie Appliquée, B.P. 452, 54001 Nancy Cedex, France; J. L. Bouchez, Laboratoire de Géologie Structurale–Tectonophysique, B.P. 1044, 44037 Nantes Cedex, France. (9 p., 14 figs., 1 tbl.)

From an extensive field study of the structural orientations within the Antalya ophiolite complex, a model for an oceanic ridge is proposed. The magmatic cumulate plane in ultramafic and mafic cumulates is restored to a horizontal orientation, and the strike of the ridge is chosen as the normal in this horizontal plane to the mineral lineation found in the foliation of the ultramafic tectonites. The lineation in these tectonites is the trace of the ductile-flow direction. It is parallel to the axis of folds developed in pyroxenite layers during ductile flow. Along the ridge strike, as defined above, the foliation has a 32° mean dip and is almost horizontal in the direction normal to the ridge strike. This suggests a mantle diapiric intrusion beneath the ridge. In the ultramafic tectonites, which are deformed in a dominantly rotational regime, the shear-flow plane has a somewhat more pronounced dip toward the ridge than does the foliation. The gabbro and pyroxenite veinlets, generated during the flow by partial melting of the peridotite, are intruded along planes containing the mineral lineation in tectonites. The isolated diabase dikes that cut all the members of the assemblage are principally subvertical with various trends and have nothing to do with the primary assemblage.

• 71206—Kinematics and regional tectonic implications of the east-trending fold belt of Peru.

V. F. Hollister, Duval International Corporation, 355 Burrard Street, Vancouver, British Columbia V6C 2G8, Canada. (7 p., 7 figs.)

An anomalous fold belt exists in northern Peru where Tertiary folds trend east rather than northwest. The axis of the Coast batholith continues to trend northwest parallel to the present coast as well as to hypothetical paleotrenches.

East-trending fold axes cross the tectonic grain established by Mesozoic events. K-Ar dates now available infer development of the fold belt within the period 65 to 40 m.y. B.P. North-south compressive forces, effective in producing the Compaccha–Agua Agria shear couple, were responsible for the east-trending folds. Apparent absence of a cratonic basement in this area may have been a factor in localizing the fold belt.

No K-Ar ages for the Coast batholith in this area are younger than 43 m.y. This period of plutonic activity ceases prior to development of the Calipuy volcanic sequence, which is now interpreted to have developed between 30 and 10 m.y. ago.

• 71207—Late Wisconsinan eolian activity near Albany, New York.

John J. Donahue, Department of Geography, University of Montana, Missoula, Montana 59801. (7 p., 8 figs., 3 tbls.)

The Albany dunes of eastern New York display parabolic and ovoid characteristics which were caused by westerly and northwesterly winds channeled through the Mohawk Valley during late Wisconsinan time. The sediment composing the dunes is moderately to poorly sorted fine sand that normally lacks rounded and frosted surfaces typical of eolian transportation. The geographic distributions of sediment mean size (Mz) and the proportions of sand in samples indicate no downwind improvement in sorting.

The dune materials were infrequently reworked, and thus the dunes did not migrate far downwind. The dunes probably formed in an edaphic desert under a topographically controlled wind regime similar to that of the present. Sediment characteristics of samples, especially the maximum deviation from a normal distribution (MDN) and spread (Sp), were used as criteria to separate windblown from nonwindblown sediments of the plains surrounding the dunes. One-half of the plain samples were not windblown, indicating that the surface sands over a large portion of the study area were not involved in the eolian activity.

• 71208—Tertiary uplift history of the Troodos massif, Cyprus.

A.H.F. Robertson, Department of Geology, University of Cambridge, Sedgwick Museum, Downing Street, Cambridge CB2 3EQ, England (present address: Grant Institute of Geology, West Mains Road, Edinburgh EH9 3JW, Scotland). (10 p., 4 figs., 1 tbl.)

The detailed uplift history of a portion of Late Cretaceous Tethyan oceanic lithosphere is documented by in situ sedimentary sequences around the Troodos massif of Cyprus. The pre-uplift tectonic setting first involved genesis of the Troodos massif at a spreading ocean ridge of Late Cretaceous age, followed by deformation in Maestrichtian time. Then, after a brief period of latest Cretaceous deep-water pelagic sedimentation, much of the area was blanketed in early Tertiary time by a wedge of pelagic carbonates derived from the northeast. Gradual uplift to the middle Miocene is documented by shallowing-upward carbonate sequences culminating in lagoons and localized reefs that were adjacent to emergent areas of vegetated and deeply weathered Troodos rocks.

A pulse of vastly accelerated middle Miocene uplift is recorded by slumping, widespread erosion, and folding of the south Troodos sedimentary sequences. This uplift was associated with rapid deposition of both clastic and carbonate sediments in subsiding basins to the south. The Miocene uplift culminated in localized reef development and gypsum deposition, then pervasive peneplanation of the Troodos massif. In contrast, much of the Troodos massif remained low-lying and tectonically stable during Pliocene time, whereas to the north, sedimentary basins developed along high-angle faults initiated during the late Miocene emplacement of the adjacent Kyrenia Range. Major uplifts during the Pleistocene epoch were renewed, as shown by thick deposits of marine and continental fanglomerates.

The uplift of Troodos oceanic crust is attributed to the progressive serpentinization of ultramafic rocks of the oceanic layer 4. These rocks, which were first deformed and partly serpentinized in Late Cretaceous time, were subsequently remobilized during periods of regional tectonic instability, especially during the middle Miocene and Pleistocene. The dominant driving force may have involved the liberation of water from a subduction zone dipping northward beneath Cyprus.

• 71209—Quaternary glaciation, west-central Maine.

Harold W. Borns, Jr., Institute for Quaternary Studies and Department of Geological Sciences, University of Maine, Orono, Maine 04473; Parker E. Calkin, Department of Geological Sciences, State University of New York at Buffalo, Buffalo, New York 14226. (12 p., 5 figs., 3 tbls.)

The highlands of west-central Maine, including the Longfellow and Boundary Mountains, were overridden at least twice, probably three times, by a continental ice sheet during Wisconsinan time. These episodes are indicated by at least five widely separated exposures displaying two-drift sequences composed of thick lodgment tills separated by glaciolacustrine and fluvial sediment. Radiocarbon dates on an intertill pollen- and wood-bearing deposit at New Sharon, Maine, record a major nonglacial interval that ended more than 52,000 B.P.

The last ice sheet, actively building end moraines along the Maine coast 13,500 yr ago, had thinned, separated, stagnated, and dissipated over the Longfellow and Boundary Mountains at least by 12,500 B.P. Contemporaneous stagnation, throughout and southeast of the mountains, is evidenced by the distribution and volume of ice-contact stratified drift. Coupled with this is the lack of evidence for receding active ice margins associated with either the Laurentide Ice Sheet or a late-glacial locally centered ice cap. In addition, the highest cirques in the study area, floored at approximately 930 m, reveal no evidence of reactivation during and subsequent to the dissipation of the last ice sheet.

• 71210—Paleomagnetism of upper Precambrian to lower Paleozoic intrusive rocks from Colorado.

R. B. French, D. H. Alexander, R. Van Der Voo, Department of Geology and Mineralogy, University of Michigan, Ann Arbor, Michigan 48109. (8 p., 11 figs., 3 tbls.)

The paleomagnetism of the Iron Mountain–McClure Mountain alkalic intrusive complex in the northern Wet Mountains of Colorado has been investigated. Published radiometric ages for the complex, and for similar intrusive rocks nearby, range between 485 and 704 m.y. Eighty-five samples were collected from 35 sites, and the samples were demagnetized using thermal and alternating-field techniques. In many samples, thermal cleaning has yielded better isolation of the primary magnetization, but the two methods yield very similar directions. The resulting directions have a trimodal distribution. One of the three groups of direction could possibly be interpreted as a later (Ordovician or late Plaeozoic?) magnetization (pole position at lat 48°N, long 107°E) and agrees well with the previous findings. However, the other two groups of directions observed in this study are interpreted with confidence as representing late Precambrian to Cambrian magnetizations. Their pole positions are 30° apart (lat 5°N, long 174°E and lat 15°N, long 142°E) and may reflect a trend of apparent polar wandering

during this time. When averaged, these two groups have a mean direction of 104° (declination) and −2° (inclination) for 21 sites (48 samples), $k = 9$, and $\alpha_{95} = 11°$. This direction yields a pole position at lat 12°N, long 165°E ($dp = 5.5°$, $dm = 11°$).

• 71211—Stratigraphy and structure of La Encantada Mine area, Coahuila, Mexico.

Gian Paolo Lozej, Frank Beales, Department of Geology, University of Toronto, Toronto, Ontario M5S 1A1. (15 p., 7 figs.)

At La Encantada, three mines produce Pb-Ag ores from deposits that occur in fracture zones in the Cretaceous Aurora limestone, within the north-northwest–trending Sierra Madre Oriental of northern Mexico. The host limestone is remarkably monotonous, almost totally lacking in diagnostic marker beds. The limestone unit is gently folded into a major anticline, the Sierra de La Encantada, which is cut by major frontal strike faults and dissected into blocks by cross-fractures and faults.

Because of the uniformity of the limestone (apart from microfossil assemblages), the area was studied by repeated sampling, thin sectioning, and detailed lithofacies and biofacies identification. A very high proportion of all thin sections contained diagnostic or partially indicative fossils. Regional mapping, begun in the field by recognizing only two rock units, was accordingly refined by laboratory analyses, and ten subdivisions of the local sequence were ultimately traceable.. These units were based on local refinements of F. Bonet's planktonic biozone scheme for the Cretaceous System of eastern Mexico. In consequence, the areas on the western flank of the anticline, where ore deposits are known, can be more precisely related to the prevalent step faulting and flank grabens of the region.

There is a preferential association of regional-scale ore-bearing fractures with sparry calcite–cemented, skeletal calcarenites. All the ore worked to date has been from heavily iron-stained, secondary, oxidized ore of complex composition. The primary ore is likely to have been argentiferous galena with sphalerite, magnetite, pyrite, and proustite. It occurs as oxidized remnants in two high-grade chimneys, originally with about one million tons in La Prieta and 350,000 tons in El Escondida; in addition, 500,000 tons occurred in a series of veins and small mantos. Recent work has uncovered a zone of lower grade but extensive sulfide tactite ore, possibly associated with the contact zone of an intrusive mass that occurs at depth. A halo of contact metamorphism, marmorization, and bleaching surrounds the ore. The alteration halo is so variable in its development as to be of little value in the search for more ore.

The most important ore-controlling structures appear to be the northeast-trending cross-fractures with which the chimneys and veins are associated. Major faults do not appear to be mineralized, presumably because they have been resealed with fault gouge. Fractures without apparent movement of the opposing surfaces and, therefore, of minor tectonic significance, at surface at least, seem to retain their dilatancy long enough to allow mineralizing fluids to surface.

• 71212—Rb-Sr age of the New Hampshire Plutonic Series.

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Rb-Sr whole-rock isochrons for four main representatives of the syntectonic to post-tectonic New Hampshire Plutonic Series yield the following ages: Kinsman Quartz Monzonite, 411 ± 19 m.y.; Bethlehem Gneiss, 405 ± 78 m.y.; Spaulding Quartz Diorite, 402 ± 5 m.y.; and Concord Granite, 359 ± 11 m.y. (or 330 ± 3 m.y.?). The Kinsman and Spaulding ages are consistent with a growing number of Rb-Sr ages determined for northern Appalachian granites, which are of Early Devonian or younger geologic age, and represent a major magmatic pulse of the Acadian orogeny. Comparison of Rb-Sr ages and geology implies that the beginning of the Devonian Period can be no later than approximately 415 m.y. and that the entire Devonian time scale needs revision.

The Concord Granite is at least 40 m.y. (possibly 70 m.y.?), younger than other members of the New Hampshire Plutonic Series, and its time of emplacement is therefore probably Late Devonian (?) or Mississippian(?).

Isochron plots imply that, although the members of the New Hampshire Plutonic Series have been derived by anatexis of lower crustal rocks, there is admixture of and contamination by mantle-derived magmatic material.

• 71213—Late Quaternary deposition of ice-rafted sand in the subpolar North Atlantic (lat 40° to 65°N).

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A major change in the North Atlantic pattern of ice-rafting deposition during the last intergalcial-glacial cycle occurred approximately 75,000 B.P. Prior to this time, deposition for a period of almost 50,000 yr during isotopic stage 5 was greatest in the northwest near Greenland and Newfoundland. The main glacial pattern was very different; the main depositional axis shifted abruptly to a zonal axis along lat 46° to 50°N, reflecting the passage of ice farther from the pole before reaching water warm enough in which to melt. This pattern remained essentially unchanged for 65,000 yr during the main Würm glaciation.

The peak interglacial depositional pattern can best be explained by analogy with the modern oceanic flow, except for the addition of a concentrated eastward component along lat 50°N. The glacial pattern is also best explained by counterclockwise flow. Laurentide and Greenlandic ice entering the western North Atlantic from the Labrador Sea moved to the east and southeast directly into the glacial depositional maximum. Scandinavian ice dropped part of its bed load near Norway, looped to the southwest into the North Atlantic in a counterclockwise passage south of Iceland, and finally melted along the primary depositional maximum.

• 71214—Displacement of relict zircons during growth of feldspathic porphyroblasts.

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Relict zircon crystals are almost invariably present in feldspathic-prophyroblastic schist and gneiss. Rounded sedimentary zircons acquire overgrowths and begin to refacet in higher-grade metamorphic events; however, new euhedral zircons composed of reconstituted material from dissolved residual crystals are thought not to form within or below the amphibolite-granulite transitional facies. Lead-loss and other alteration effects do not destroy or remove traces of the original zircon grains.

Zircon distribution within even-grained igneous rock is essentially random, and clastic sedimentary rocks have grains concentrated as heavy minerals is lenses or sheets related to bedding. Variations in these patterns of distribution are found in porphyroblastic schists and gneisses, and they suggest that relict zircons have been physically displaced outward during the growth of feldspathic porphyroblasts. Zircons in all rocks examined increase in concentration within the wrapped-around biotite-rich shells enclosing feldspathic augen and porphyroblasts. At the same time, data show that relict zircons have been systematically removed from the region of porphyroblast growth.

Explanations suggesting compaction of matrix and (or) replacement coupled with ionic migration appear inadequate to fully describe the growth of these porphyroblasts and the creation of their wrapped-around shells. Physical displacement due to "force of crystallization" is suggested as a required mechanism during the formation of these porphyroblasts.

• 71215—Petrology of Tertiary and Quaternary volcanic rocks, Washington County, southwestern Utah.

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In Washington County, southwestern Utah, a thick sequence of volcanic rocks ranges in age from latest Oligocene to Holocene. The Tertiary units consist predominantly of ash flows of intermediate calc-alkalic composition, whereas the youngest volcanic rocks are mostly basaltic andesites. Thermochemical calculations indicate that some of the mafic lavas could be derived from melting of spinel peridotite within the upper part of the low-velocity zone at depths of 50 to 65 km. Some basaltic andesites contain megacrysts of quartz; if the quartz is cognate, the magmas may have formed by partial fusion of quartz eclogite at depths of approximately 120 to 150 km. We suggest that this quartz eclogite is a remnant of the Farallon plate, which underwent subduction at the time of calc-alkalic Tertiary volcanism.

• 71216—Rb-Sr geochronology and evolution of the Grenville province in northwestern Quebec, Canada.

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The La Vérendrye Park area extends from the Grenville front near Val d'Or, Quebec, to the beginning of the cover formed by rocks of the Grenville Supergroup some 200 km southeast of the front. Most of the rocks in the study area are layered quartzofeldspathic gneisses of uncertain origin, metamorphosed to the granulite facies.

For the first 50 km southeast of the front, the gneisses yield fairly precise Rb-Sr isochron estimates of the times of their metamorphism 2,450 to 2,850 m.y. ago. Throughout the central part of the area, lithologically similar rocks have commonly been affected by a later metamorphic event; they yield a variety of results ranging from a random distribution of isotopic data to very poorly defined ages of about 2,000 m.y., which are interpreted as being intermediate between the ages of two metamorphic episodes.

Demonstrably intrusive igneous rocks are very rare in the northern and central parts of the area. A metasomatic origin for the fairly abundant granitic (microcline-rich) layers in the gneisses is supported by isotopic and petrographic evidence and by their relationship to the enclosing quartz-oligoclase gneisses. Similar evidence suggests that this granitization is an Archean phenomenon in the northern half of the area.

Farther south, the zone of migmatite between 150 and 200 km southeast of the Grenville front consists of granitic and charnockitic rocks that yield ages of about 1,150 m.y. and locally high initial $^{87}Sr/^{86}Sr$ ratios. The host rocks are interfolded Archean and Aphebian quartzofeldspathic gneisses. The latter are a group of metasedimentary rocks that are distinct in lithology from the Archean gneisses and the sedimentary rocks of the Grenville Supergroup and yield a reliable metamorphic age of 1,650 m.y. and a low initial $^{87}Sr/^{86}Sr$ ratio.

When this information is added to that from other more southern regions, the evolution of this part of the shield is inferred to be dominantly accretionary but includes a very significant overlap of Grenville Supergroup rocks on Aphebian continental crust. The Grenville front in this area probably represents a zone of vertical movement that exhumed a 100-km-wide strip of high-grade Archean rocks, which presumably had lain under and adjacent to the Abitibi foldbelt. South of the La Vérendrye Park area, Archean rocks have not been identified in close association with rocks of the Grenville Supergroup, and older rocks have not contributed significantly to the generation of plutonic rocks of Grenville age except in the boundary zone described in this paper.

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